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B

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: McArthur et al.
Serial No.: 10/039,426 ✓
Cust. No.: 33123
Filed: 01/14/2002
For: *METHOD AND APPARATUS FOR
PROPER ORDERING OF
REGISTRATION DATA*
Art Unit: 2851
Examiner: C. Young

CERTIFICATE OF MAILING

I hereby certify that this correspondence and the attached papers are being deposited with the United States Postal Service with sufficient postage as first class mail on the date indicated below and are addressed to:

Mail Stop Issue Fee
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

4/29/04
Date

Michelle Melendy
Signature

RESPONSE TO NOTICE OF DRAWING INCONSISTENCY

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicants received a "Notice of Drawing Inconsistency with Specification" mailed on April 23, 2004 that requested correction of the drawings filed with the specification on January 4, 2002 so they match the description in the specification for Figure 5 and Figure 14. It is believed that no inconsistency appears, if amendments filed in this application after January 4, 2002 are considered.

In a Response to Notice of Missing Parts filed on April 8, 2002, substitute drawings were provided that contained the same figures as the original drawings, except that the substitute drawings were more distinct (formal drawings) and the drawing figure references were clarified for Figure 5 and Figure 14. On that same date (April 8, 2002), a preliminary amendment was filed that conformed the Brief Description of Drawings to the substitute drawings with respect to Figure 5 and Figure 14. The substitute drawings and amended specification are consistent with each other and obviate the issues raised in the "Notice of Drawing Inconsistency".

Serial No. 10/039,426
McArthur et al.
Response to Notice of Drawing Inconsistency

To ensure that the Office application file has the documents referred to above, the documents are being submitted once again, with this Response. Enclosed are the following items:

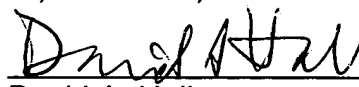
- 1) Copy of Response to Notice to File Missing Parts of Application as filed on April 8, 2002;
- 2) Copy of Substitute Drawings as attached to Response to Notice of April 8, 2002;
- 3) Copy of Return Postcard as submitted with Response to Notice to File Missing Parts of Application of April 8, 2002;
- 4) Copy of date-stamped Return Postcard received from the Patent Office;
- 5) Copy of Check in the amount of \$65.00 for Response; and
- 6) Copy of Preliminary Amendment filed April 8, 2002.

It is submitted that the Response to Notice of Missing Parts and the Preliminary Amendment filed on April 8, 2002, when taken together, eliminate any discrepancy between the drawings and the specification, and obviate the Notice of Drawing Inconsistency mailed on April 23, 2004. It is requested that the Notice be withdrawn and the patent issued in accordance with the substitute drawings and preliminary amendment.

[X] The Commissioner is hereby authorized to charge any fees that may be due under 37 C.F.R. §§1.16-1.17 in connection with this paper or with this application during its entire pendency to Deposit Account No. 50-1213. A duplicate of this sheet is enclosed.

Respectfully submitted,
HELLER, EHRMAN, WHITE & McAULIFFE LLP

By:



David A. Hall
Registration No. 32,233

Attorney Docket No.: 38203-6079
HELLER EHRMAN WHITE & McAULIFFE LLP
4350 La Jolla Village Dr., Suite 700
San Diego, CA 92122-1246
Telephone: (858) 450-8400 Facsimile: (858) 450-8499
Email: dhall@hewm.com

SD 660307 v1 (38203.6079)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of B. McArthur et al.

Application No.: 10/039,426

Filed: January 4, 2002

Conf. No.: 8965

For: METHOD AND APPARATUS FOR
PROPER ORDERING OF
REGISTRATION DATA



CERTIFICATE OF MAILING PURSUANT TO 37 CFR 1.8
I hereby certify that this paper is being deposited in the United States mail as first class [Priority] mail with postage prepaid, and is addressed to:

Commissioner for Patents, U.S. Patent and Trademark Office,
P.O. Box 2327, Arlington, VA 22202, on

Date 4/1/02 Michelle Maboude

RESPONSE TO NOTICE TO FILE MISSING PARTS OF APPLICATION

Commissioner for Patents
Box Missing Parts
U.S. Patent and Trademark Office
P.O. Box 2327
Arlington, VA 22202

Sir:

In response to the Notice to File Missing Parts of Application mailed February 7, 2001, the following documents are submitted with this Response:

- 1) A copy of the Notice to File Missing Parts;
- 2) A check in the amount of \$65.00 to cover the surcharge;
- 3) Declaration for Patent Application;
- 4) Substitute Drawings (16 sheets); and
- 5) Return Postcard for this transmittal.

☒ The Commissioner is hereby authorized to charge any fee, including any submitted herewith if the attached check(s) is in the wrong amount or otherwise improper or missing, that may be due in connection with this and the attached papers, or with this application during its entire pendency to or to credit any overpayment to Deposit Account No. 50-1213. A duplicate of this sheet is enclosed.

Respectfully submitted,

David A. Hall
David A. Hall
Reg. No. 32,233

Heller Ehrman White & McAuliffe LLP
4350 La Jolla Village Drive, 6th Floor
San Diego, California 92122-1246
Telephone: (858) 450-8400



UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/039,426	01/04/2002	B. McArthur	38203-6079

MAY 04 2004

CONFIRMATION NO. 8965

FORMALITIES LETTER



OC00000007455122

David A. Hall
Heller Ehrman White & McAuliffe LLP
7th Floor
4350 La Jolla Village Drive
San Diego, CA 92122-1246

Date Mailed: 02/11/2002

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

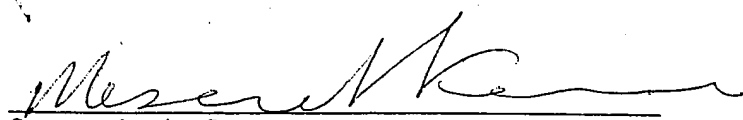
- The oath or declaration is missing.
A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(l) of \$65 for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this letter.
- The balance due by applicant is \$ 65.

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Substitute drawings in compliance with 37 CFR 1.84 because:
 - drawing sheets do not have the appropriate margin(s) (see 37 CFR 1.84(g)). Each sheet must include a top margin of at least 2.5 cm. (1 inch), a left side margin of at least 2.5 cm. (1 inch), a right side margin of at least 1.5 cm. (5/8 inch), and a bottom margin of at least 1.0 cm. (3/8 inch);

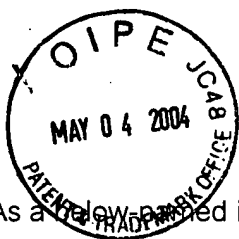
*A copy of this notice **MUST** be returned with the reply.*



Customer Service Center

Initial Patent Examination Division (703) 308-1202

PART 2 - COPY TO BE RETURNED WITH RESPONSE



DECLARATION FOR PATENT APPLICATION

As a sole inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR PROPER ORDERING OF REGISTRATION DATA

the specification of which

- ☐ is attached hereto.
- ☒ was filed by an authorized person on my behalf on January 4, 2002 as Application Serial No. 10/039,426 (applicant's attorney is authorized to enter application number after execution of this document).
- ☐ and as amended [if applicable].

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate listed below and so identified, or §365(a) of any PCT international application that designated at least one country other than the United States of America, listed below, and I have also identified below any foreign application for patent or inventor's certificate or PCT international application on this invention filed by me or my legal representatives or assigns and having a filing date before that of the application on which priority is claimed.

Priority
Claimed
(Yes or No)

<u>Number</u>	<u>Country</u>	<u>Day/Month/Year Filed</u>
---------------	----------------	-----------------------------

N/A

I hereby claim benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

<u>Application Serial No.</u>	<u>Filing Date</u>
60/259,873	January 5, 2001

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.

N/A

Filing Date

Status

PCT Application No.

N/A

Filing Date

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorneys and agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith and request that all correspondence and telephone calls in respect to this application be directed to David A. Hall, HELLER EHRMAN WHITE AND McAULIFFE LLP, 4350 La Jolla Village Drive, 7th Floor, San Diego, California 92122-1246; (858) 450-8400:

Attorney

Reg. No.

David A. Hall

32,233

Stephanie Seidman

33,779

Paula Schoeneck

39,362

Dale L. Rieger

43,045

Gary Silverstein

39,372

Fred C. Hernandez

41,832

William B. Anderson

41,585

Robert T. Ramos

37,915

and other members of the firm.

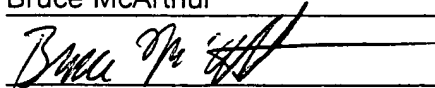
Address for correspondence:

David A. Hall
HELLER EHRMAN WHITE AND McAULIFFE LLP
4350 Executive Square, 7th Floor
San Diego, California 92122-1246

Full name of first inventor:

Bruce McArthur

Inventor's signature:



Date:

1/17/02

Residence:

San Diego, California

Post Office Address:

4143 Bonanza

San Diego, California 92117

Citizenship:

USA

Full.name of second inventor:

Adlai Smith

Inventor's signature:

Adlai Smith

1/18/02

Date:

Residence:

Escondido, California

Post Office Address:

2920 Summit Drive

Escondido, California 92025

Citizenship:

USA

179867 v01.SD (3%SB01!.DOC) (38203.6079)

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Client #: 38203-6079/Litel (DAH:msm)

Enclosures: Response to Notice to File Missing Parts of
Application, 1 page original and in duplicate; Copy of
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Application, 2 pages; Declaration for Patent Application,
3 pages; Check in the amount of \$65.00; Substitute
Drawings, 16 sheets; This Postcard.

For: METHOD AND APPARATUS FOR PROPER
ORDERING OF REGISTRATION DATA

Applicant(s): B. McArthur et al.

Application No.: 10/039,426 - Filed: 1/4/02

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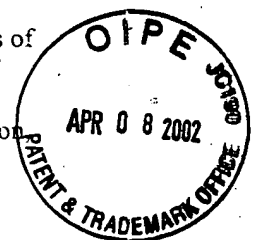
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For: METHOD AND APPARATUS FOR PROPER
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Applicant(s): B. McArthur et al.

Application No.: 10/039,426 - Filed: 1/4/02

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ATTORNEYS

Heller Ehrman White & McAuliffe LLP
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Client #: 38203-6079/Litel (DAH:msm)

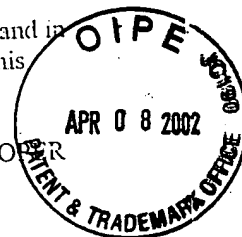
Enclosures: Transmittal Letter, 1 page original and in
duplicate; Preliminary Amendment, 10 pages; This
Postcard.

For: METHOD AND APPARATUS FOR PROPER
ORDERING OF REGISTRATION DATA

Applicant(s): B. McArthur et al.

Application No.: 10/039,426 - Filed: 1/4/02

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Client #: 38203-6079/Litel (DAH:rsm)

Enclosures: Transmittal Letter, 1 page original and in
duplicate; Preliminary Amendment, 10 pages; This
Postcard.

For: METHOD AND APPARATUS FOR PROPER
ORDERING OF REGISTRATION DATA
Applicant(s): B. McArthur et al.
Application No.: 10/039,426 - Filed: 1/4/02
PLEASE STAMP HERE. THANK YOU.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: McARTHUR, *et al.*
Serial No.: 10/039,426
Conf. No.: 8965
Filed: January 4, 2002
For: *METHOD AND APPARATUS FOR
PROPER ORDERING OF
REGISTRATION DATA*
Art Unit: 2851
Examiner: Unassigned

I hereby certify that this paper and the attached
papers are being deposited with the United States
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addressed to:

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US Patent and Trademark Office
PO Box 2327
Arlington, VA 22202, on this date.

4/1/02
Date

Michelle Melendez
Michelle Melendez

TRANSMITTAL LETTER

Commissioner for Patents
US Patent and Trademark Office
PO Box 2327
Arlington, VA 22202

Sir:

Transmitted herewith is a Preliminary Amendment with an attachment of marked up paragraphs for filing in connection with the above-identified application. Because this Preliminary Amendment is filed prior to receipt of a first office action on the merits in the above-referenced application, no fee is due. However, should it be determined that a fee for filing these papers is required, the Commissioner is authorized to charge Deposit Account No. 50-1213, as stated below:

[X] The Commissioner is hereby authorized to charge any fees that may be due under 37 C.F.R. §§1.16-1.17 in connection with this paper or with this application during its entire pendency to Deposit Account No. 50-1213. A duplicate of this sheet is enclosed.

Respectfully submitted,
HELLER, EHRMAN, WHITE & McAULIFFE LLP

By: *David A. Hall*
David A. Hall
Registration No. 32,233

Attorney Docket No.: 25380-6055
Address all correspondence to:
David A. Hall
HELLER EHRMAN WHITE & McAULIFFE LLP
4350 La Jolla Village Drive, 7th Floor
San Diego, CA 92122-1246
Telephone: (858) 450-8400 Facsimile: (858) 587-5360
EMAIL: dhall@hewm.com

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: McARTHUR, *et al.*
Serial No.: 10/039,426
Conf. No.: 8965
Filed: January 4, 2002
For: *METHOD AND APPARATUS FOR
PROPER ORDERING OF
REGISTRATION DATA*
Art Unit: 2851
Examiner: Unassigned

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Commissioner for Patents
US Patent and Trademark Office
PO Box 2327
Arlington, VA 22202, on this date.

4/1/02
Date

Michelle Melendez
Michelle Melendez

TRANSMITTAL LETTER

Commissioner for Patents
US Patent and Trademark Office
PO Box 2327
Arlington, VA 22202

Sir:

Transmitted herewith is a Preliminary Amendment with an attachment of marked up paragraphs for filing in connection with the above-identified application. Because this Preliminary Amendment is filed prior to receipt of a first office action on the merits in the above-referenced application, no fee is due. However, should it be determined that a fee for filing these papers is required, the Commissioner is authorized to charge Deposit Account No. 50-1213, as stated below:

[X] The Commissioner is hereby authorized to charge any fees that may be due under 37 C.F.R. §§1.16-1.17 in connection with this paper or with this application during its entire pendency to Deposit Account No. 50-1213. A duplicate of this sheet is enclosed.

Respectfully submitted,
HELLER, EHRMAN, WHITE & McAULIFFE LLP

By:

David A. Hall

David A. Hall
Registration No. 32,233

Attorney Docket No.: 25380-6055
Address all correspondence to:
David A. Hall
HELLER EHRMAN WHITE & McAULIFFE LLP
4350 La Jolla Village Drive, 7th Floor
San Diego, CA 92122-1246
Telephone: (858) 450-8400 Facsimile: (858) 587-5360
EMAIL: dhall@hewm.com

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: McARTHUR, *et al.*

Serial No.: 10/039,426

Conf. No.: 8965

Filed: January 4, 2002

For: *METHOD AND APPARATUS FOR
PROPER ORDERING OF
REGISTRATION DATA*

Art Unit: 2851

Examiner: Unassigned

I hereby certify that this paper and the attached papers are being deposited with the United States Postal Service as first class mail in an envelope addressed to:

Commissioner for Patents
US Patent and Trademark Office
PO Box 2327
Arlington, VA 22202, on this date.

4/10/02
Date

Michelle Melendez
Michelle Melendez

PRELIMINARY AMENDMENT

Commissioner for Patents
US Patent and Trademark Office
PO Box 2327
Arlington, VA 22202

Dear Sir:

Preliminary to examination of the above-captioned patent application, please amend the specification as follows:

IN THE SPECIFICATION:

Please amend the specification as follows (a marked up copy of the amended specification is attached to this Amendment):

Please replace the paragraph at page 3, lines 3-19, with the following:

Figure 5(a) shows a typical overlay displacement vector 502 representing the x-shift and y-shift vector overlay error associated with a misaligned frame-in-frame alignment attribute. In some cases the overlay error can be measured using special in-situ exposure tool metrology See Direct-referencing automatic two-points reticle-to-wafer alignment using a projection column servo system, *supra*. Many

U.S.S.N 10/039,426
McARTHUR, et al.
PRELIMINARY AMENDMENT

commercial software packages exist (see A Computer Aided Engineering Workstation for Registration Control, E. McFadden, C. Ausschnitt, SPIE Vol. 1087, 255:266 1989; Matching of Multiple Wafer Steppers for 0.35 Micron Lithography using Advanced Optimization Schemes, M. van den Brink, et al., SPIE Vol. 1926, 189:207, 1993, (hereinafter Klass II)) that model and statistically determine the relative magnitude of the systematic and random inter-field and intra-field error components for the purpose of process control, projection lens adjustment, wafer stage calibration, and exposure tool set-up. Other methods such as described in U.S. Patent No. 5,978,085 and U.S. Patent No. 5,828,455 both entitled "APPARATUS, METHOD OF MEASUREMENT, AND METHOD OF DATA ANALYSIS FOR CORRECTION OF OPTICAL SYSTEM" to Adlai Smith, Bruce McArthur, and Robert Hunter, and both incorporated in their entirety herein, use overlay techniques to determine the lens aberrations of the photolithographic exposure tool or machine.

Please replace the paragraph at page 4, lines 6-16, with the following:

For some applications, such as very high rate overlay sampling on semiconductor production wafers, overlay registration results are not that sensitive to the exact sampling in terms of target position and other parameters. For example, a typical semiconductor manufacturing facility might, for purposes of process control, monitor the day to day alignment accuracy of an photolithographic tool by measuring a small number of overlay targets on a small group of production wafers, see for example Figures 14(a), 14(b), 14(c) and 15(b). See Semiconductor Pattern Overlay, N. Sullivan, SPIE Critical Reviews Vol. CR52, 160:188; Super Sparse Overlay Sampling Plans: An Evaluation of Methods and Algorithms for Optimizing Overlay Quality Control and Metrology Tool Throughput, J. Pellegrini, SPIE Vol. 3677, 72:82, 36220.

U.S.S.N 10/039,426
McARTHUR, *et al.*
PRELIMINARY AMENDMENT

Please replace the paragraph at page 8, lines 5-6, with the following:

Figures 5(b1) - 5(b4) are a schematic diagram showing typical overlay errors associated with prior art systems.

Please replace the paragraph at page 9, lines 2-3, with the following:

Figures 14(a) - 14(c) are a schematic showing a prior art overlay exposure patterns for process monitoring and stepper qualification.

Please replace the paragraph at page 11, lines 14-22, with the following:

Conventional methods for collecting overlay data include programming an overlay tool with a set of software instructions that instruct the overlay tool to measure the alignment attributes or overlay targets in a distinct order, see for example Figures 14(a), 14(b), 14(c), 15(a), 15(b), and 15(c). The labeling and identification of the overlay output data usually depends on the type of overlay tool used to measure the alignment attributes. For example, the KLA 5100 series of tools use a complicated coding system that requires a fair degree of interpretation to decode the output data. See KLA 5105 overlay brochure, *supra*; KLA 5200 overlay brochure, *supra*. Other tools, like the BioRad Quaestor-Q7 simply label the output data by position, matching each registration error to its unique field point.

Please replace the paragraph at page 12, lines 1-18, with the following:

Most overlay tools are programmed to measure the alignment attributes in close proximity of many other similar looking features. Typically, overlay tools use an optical recognition routine to identify each alignment attribute just prior to measurement. Sometimes, the optical recognition system can read the wrong alignment attribute or a similar looking feature in a systematic way. If it is simply assumed that the overlay tool has identified the correct alignment attribute and one proceeds to use the program for production measurements, the data can become corrupt. In addition, many times the alignment attributes and wafer exposure patterns are symmetric with respect to the notch of the wafer, as illustrated in

Figures 14(a), 14(b) and 14(c). The symmetry can cause confusion when trying to set-up and debug the overlay machine instructions to read the alignment attributes in a unique order. For most production applications, unorganized, missing and slightly corrupt overlay data can be accounted for. For example, most production overlay routines measure the alignment attributes wafer-to-wafer and use statistical techniques to determine the average amount of overlay error associated with the production lot as a whole, thus missing and unorganized overlay data is accounted for statistically. While averaging data reduces the effect of erroneously identified data points, averaging data is not desirable because it can reduce the accuracy of the result. It is therefore desirable to have a technique that can eliminate these errors.

Please replace the paragraphs at page 18, line 22 through page 20, line 3, with the following:

A fourth encoding scheme example can be used to monitor the performance of the overlay tool in regards to special photolithographic process induced effects that corrupt the overlay data in a unique way. Typically, a critical dimension (CD) diminution in an "egg crate" structure across each field point is observed, see for example Figures 5(b1), 5(b2), 5(b3) and 5(b4). If the overlay job deck does not account for these process induced CD variations the overlay tool might read incorrectly as it steps target to target across a given field point array. In particular, instead of measuring the offsets relative to the egg-crate centerline, we may be measuring it relative to the edges which when combined with the above-mentioned CD variation will lead to erroneous results. To identify and correct these problems the reticle pattern is deviated by forcing the CDs of the outer frame structures to decrease as a function of the position within the field point array according to equations (6) and (7), and illustrated in Figure 5(a). For this encoding scheme the CDs of the horizontal and vertical bars that define the outer frame structure are modified, for example reduced, as a function of the position across the field point in ~10nm steps.

U.S.S.N 10/039,426
McARTHUR, *et al.*
PRELIMINARY AMENDMENT

The CD diminution effect usually shows up as the wrong result in the overlay data for those overlay tools/jobs that are sensitive to this particular CD variation, e.g. overlay jobs that have been incorrectly set up. Thus as illustrated in Figure 5(c), an inner box is perfectly centered (offset=0) between two lines with different CD's when the overlay job is set up correctly to make a bar-in-bar type measurement. While in Figure 5d, the same alignment attribute will now produce a non-zero offset when set up (incorrectly) as a bar-in-box measurement. Figures 5(b1), 5(b2), 5(b3) and 5(b4) further illustrate this diminution error and how it might introduce overlay noise. For the example of frame-in-frame structures, an overlay tool or job deck that is not sensitive to these CD variations will measure only the programmed offsets from encoding scheme Example (3) described above and illustrated in Figures 5(a) and 5(b1), 5(b2), 5(b3) and 5(b4). Therefore, if the overlay tool produces incorrect measurements in a pattern that matches our fourth encoding scheme the overlay job deck will have to be modified to account for the diminution effect.

REMARKS

Any fees that may be due in connection with this application throughout its pendency may be charged to Deposit Account No. 50-1213.

The specification is amended to adjust the references to Figures 5(b) and 14 to reflect corrections to these drawing figures. No new matter has been added to the specification.

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In view of the amendments and above remarks, entry of the amendments and examination of the application on the merits are respectfully requested.

Respectfully submitted,
HELLER EHRMAN WHITE & McAULIFFE LLP

By: 
David A. Hall
Registration No. 32,233

Attorney Docket No. 38203-6079

Address all correspondence to:

David A. Hall
HELLER EHRMAN WHITE & McAULIFFE LLP
4350 La Jolla Village Drive, Suite 600
San Diego, CA 92122-1246
Telephone: (858) 450-8400 Facsimile: (858) 587-5360
EMAIL: dhall@hewm.com

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: McARTHUR, *et al.*
Serial No.: 10/039,426
Conf. No.: 8965
Filed: January 4, 2002
For: METHOD AND APPARATUS FOR
PROPER ORDERING OF
REGISTRATION DATA
Art Unit: 2851
Examiner: Unassigned

ATTACHMENT TO THE PRELIMINARY AMENDMENT
MARKED UP PARAGRAPHS AND CLAIMS (37 CFR §1.121)

IN THE SPECIFICATION:

Please amend the specification as follows:

Please amend the paragraph on page 3, lines 3-19, as follows:

Figure 5(a) shows a typical overlay displacement vector 502 representing the x-shift and y-shift vector overlay error associated with a [miss-aligned]~~misaligned~~ frame-in-frame alignment attribute. In some cases the overlay error can be measured using special in-situ exposure tool metrology See Direct-referencing automatic two-points reticle-to-wafer alignment using a projection column servo system, *supra*. Many commercial software packages exist (see A Computer Aided Engineering Workstation for Registration Control, E. McFadden, C. Ausschnitt, SPIE Vol. 1087, 255:266 1989; Matching of Multiple Wafer Steppers for 0.35 Micron Lithography using Advanced Optimization Schemes, M. van den Brink, et al., SPIE Vol. 1926, 189:207, 1993, (hereinafter Klass II)) that model and statistically determine the relative magnitude of the systematic and random inter-field and intra-field error components for the purpose of process control, projection lens adjustment, wafer stage calibration, and exposure tool set-up. Other methods such as described in U.S. Patent No. 5,978,085 and U.S. Patent No. 5,828,455 both

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entitled "APPARATUS, METHOD OF MEASUREMENT, AND METHOD OF DATA ANALYSIS FOR CORRECTION OF OPTICAL SYSTEM" to Adlai Smith, Bruce McArthur, and Robert Hunter, and both incorporated in their entirety herein, use overlay techniques to determine the lens aberrations of the photolithographic exposure tool or machine.

Please amend the paragraph on page 4, lines 6-16, as follows:

For some applications, such as very high rate overlay sampling on semiconductor production wafers, overlay registration results are not that sensitive to the exact sampling in terms of target position and other parameters. For example, a typical semiconductor manufacturing facility might, for purposes of process control, monitor the day to day alignment accuracy of an photolithographic tool by measuring a small number of overlay targets on a small group of production wafers, see for example Figures 14(a), 14(b), 14(c) and 15(b). See Semiconductor Pattern Overlay, N. Sullivan, SPIE Critical Reviews Vol. CR52, 160:188; Super Sparse Overlay Sampling Plans: An Evaluation of Methods and Algorithms for Optimizing Overlay Quality Control and Metrology Tool Throughput, J. Pellegrini, SPIE Vol. 3677, 72:82, 36220.

Please amend the paragraph on page 8, lines 5-6, as follows:

[Figure 5(b) is] Figures 5(b1) - 5(b4) are a schematic diagram showing typical overlay errors associated with prior art systems.

Please amend the paragraph on page 9, lines 2-3, as follows:

[Figure 14 is] Figures 14(a) - 14(c) are a schematic showing a prior art overlay exposure patterns for process monitoring and stepper qualification.

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Please amend the paragraph on page 11, lines 14-22, as follows:

Conventional methods for collecting overlay data include programming an overlay tool with a set of software instructions that instruct the overlay tool to measure the alignment attributes or overlay targets in a distinct order, see for example Figures 14(a), 14(b), 14(c), 15(a), 15(b), and 15(c). The labeling and identification of the overlay output data usually depends on the type of overlay tool used to measure the alignment attributes. For example, the KLA 5100 series of tools use a complicated coding system that requires a fair degree of interpretation to decode the output data. See KLA 5105 overlay brochure, *supra*; KLA 5200 overlay brochure, *supra*. Other tools, like the BioRad Quaestor-Q7 simply label the output data by position, matching each registration error to its unique field point.

Please amend the paragraph on page 12, lines 1-18, as follows:

Most overlay tools are programmed to measure the alignment attributes in close proximity of many other similar looking features. Typically, overlay tools use an optical recognition routine to identify each alignment attribute just prior to measurement. Sometimes, the optical recognition system can read the wrong alignment attribute or a similar looking feature in a systematic way. If it is simply assumed that the overlay tool has identified the correct alignment attribute and one proceeds to use the program for production measurements, the data can become corrupt. In addition, many times the alignment attributes and wafer exposure patterns are symmetric with respect to the notch of the wafer, as illustrated in [Figure 14]Figures 14(a), 14(b) and 14(c). The symmetry can cause confusion when trying to set-up and debug the overlay machine instructions to read the alignment attributes in a unique order. For most production applications, unorganized, missing and slightly corrupt overlay data can be accounted for. For example, most production overlay routines measure the alignment attributes wafer-to-wafer and use statistical techniques to determine the average amount of overlay error associated with the production lot as a whole, thus missing and unorganized overlay data is

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accounted for statistically. While averaging data reduces the effect of erroneously identified data points, averaging data is not desirable because it can reduce the accuracy of the result. It is therefore desirable to have a technique that can eliminate these errors.

Please amend the paragraphs on page 18, line 22 through page 20, line 3, as follows:

A fourth encoding scheme example can be used to monitor the performance of the overlay tool in regards to special photolithographic process induced effects that corrupt the overlay data in a unique way. Typically, a critical dimension (CD) diminution in an "egg crate" structure across each field point is observed, see for example [Figure 5(b)]Figures 5(b1), 5(b2), 5(b3) and 5(b4). If the overlay job deck does not account for these process induced CD variations the overlay tool might read incorrectly as it steps target to target across a given field point array. In particular, instead of measuring the offsets relative to the egg-crate centerline, we may be measuring it relative to the edges which when combined with the above-mentioned CD variation will lead to erroneous results. To identify and correct these problems the reticle pattern is deviated by forcing the CDs of the outer frame structures to decrease as a function of the position within the field point array according to equations (6) and (7), and illustrated in Figure 5(a). For this encoding scheme the CDs of the horizontal and vertical bars that define the outer frame structure are modified, for example reduced, as a function of the position across the field point in ~10nm steps.

The CD diminution effect usually shows up as the wrong result in the overlay data for those overlay tools/jobs that are sensitive to this particular CD variation, e.g. overlay jobs that have been incorrectly set up. Thus as illustrated in Figure 5(c), an inner box is perfectly centered (offset=0) between two lines with different CD's when the overlay job is set up correctly to make a bar-in-bar type measurement. While in Figure 5d, the same alignment attribute will now produce a non-zero offset when set

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up (incorrectly) as a bar-in-box measurement. [Figure 5(b)]~~Figures 5(b1), 5(b2), 5(b3) and 5(b4)~~ further [illustrates]~~illustrate~~ this diminution error and how it might introduce overlay noise. For the example of frame-in-frame structures, an overlay tool or job deck that is not sensitive to these CD variations will measure only the programmed offsets from encoding scheme Example (3) described above and illustrated in Figures 5(a) and [5(b)]~~5(b1), 5(b2), 5(b3) and 5(b4)~~. Therefore, if the overlay tool produces incorrect measurements in a pattern that matches our fourth encoding scheme the overlay job deck will have to be modified to account for the diminution effect.

184259 v01.SD (3Y6B01!.DOC) (38203.6079)

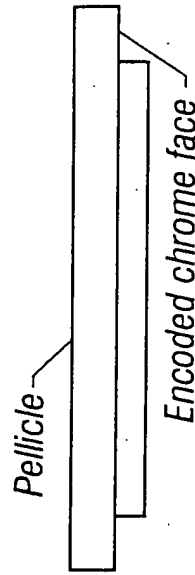


FIG. 1B

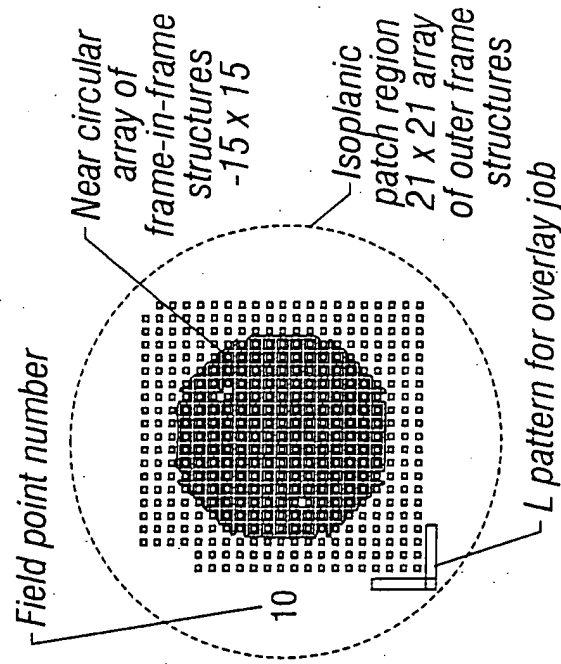


FIG. 1C

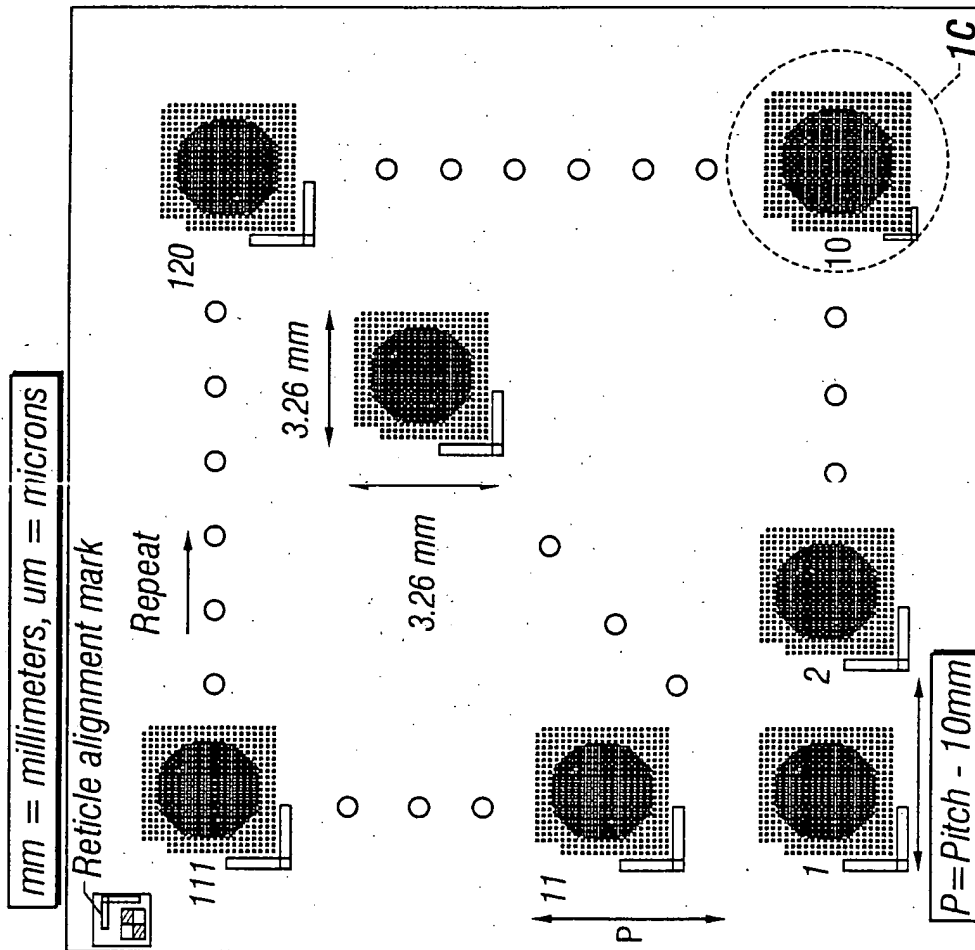
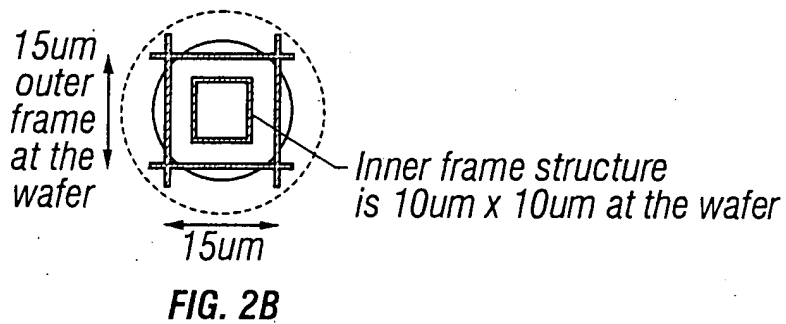
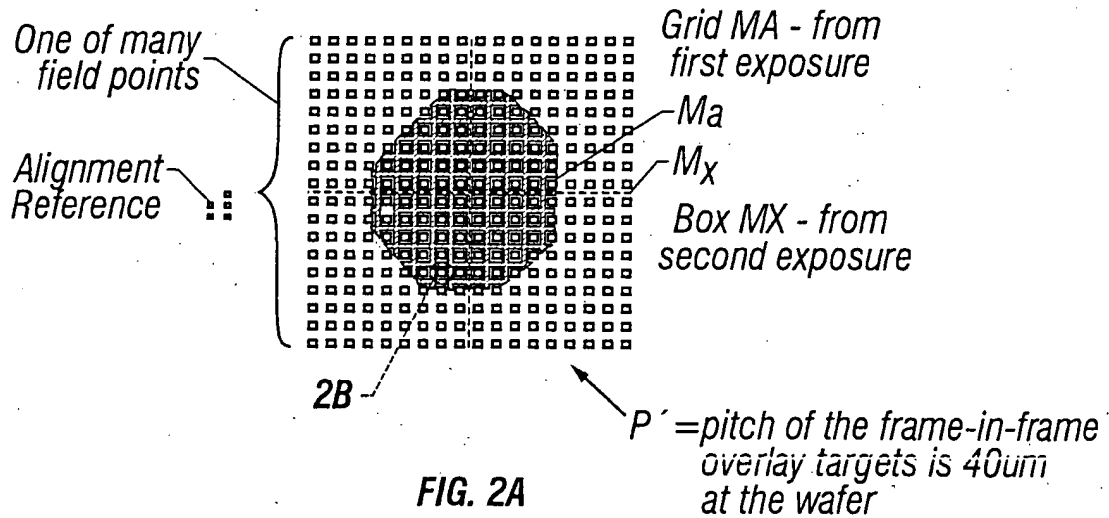
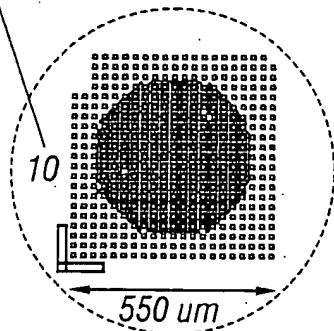
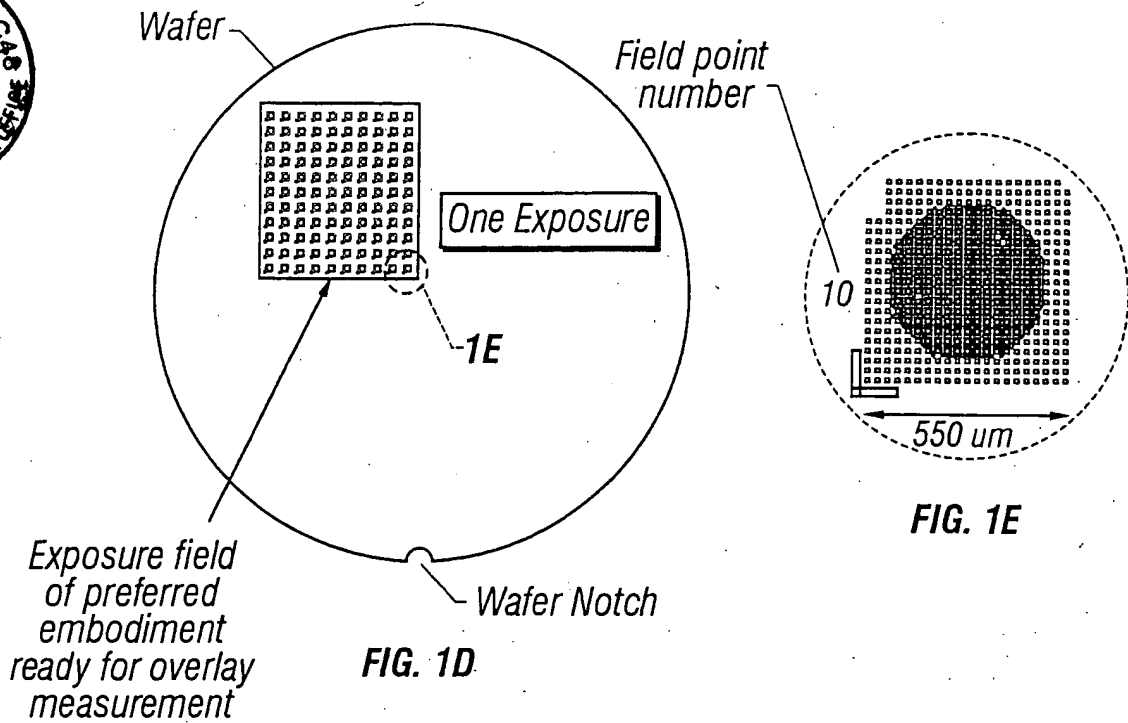


FIG. 1A





Y coordinate label

Each row of space between sites is labeled as one ISA

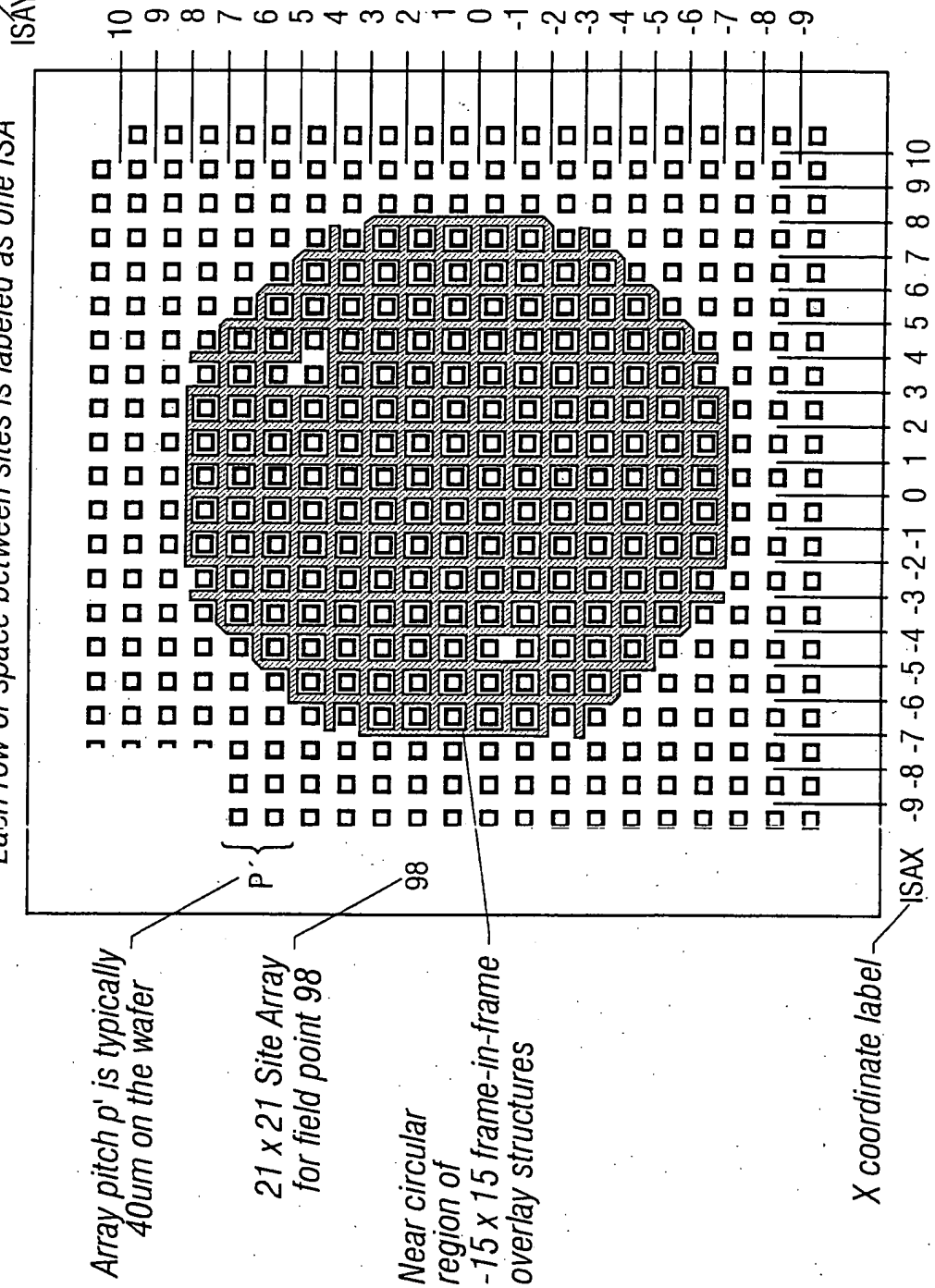
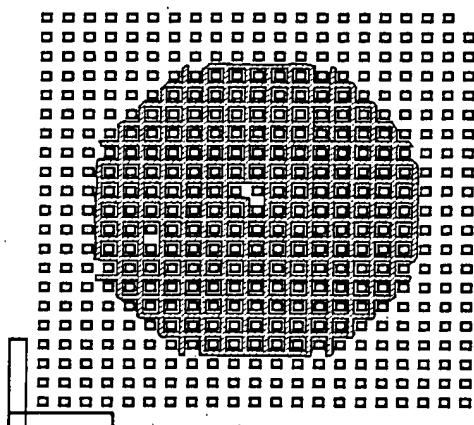
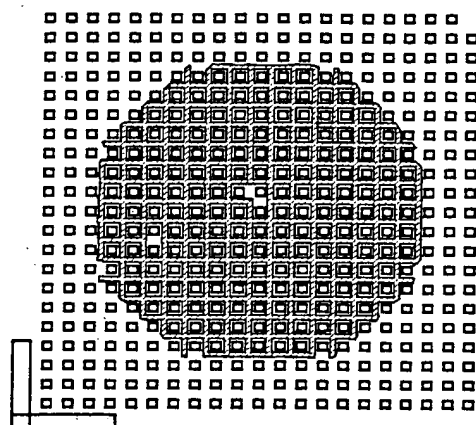


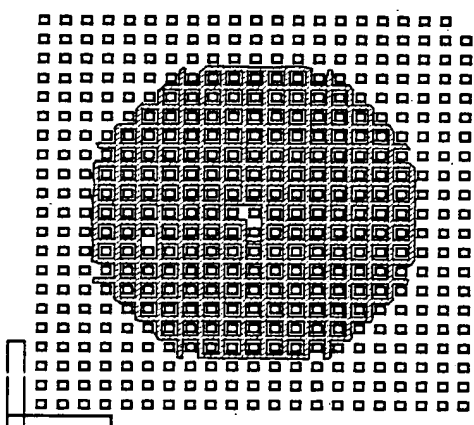
FIG. 3



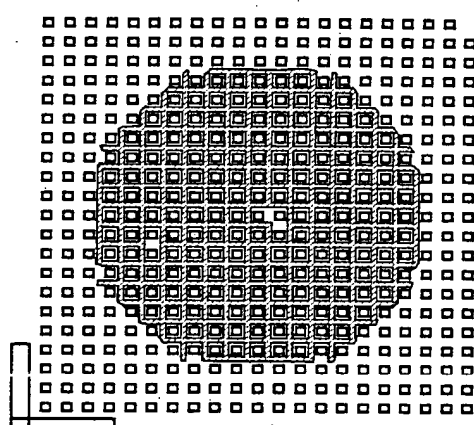
65



66



55



56

FIG. 4A



Field point 98 has
the following
coordinates:

$IXFP=8, IYFP=10$

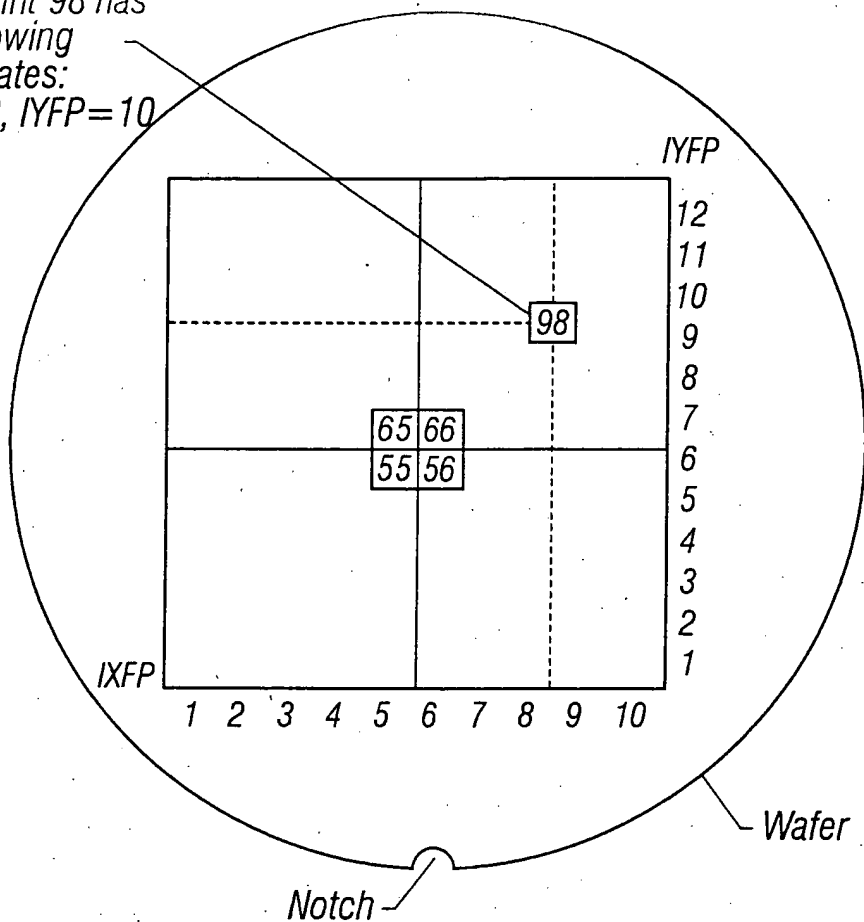


FIG. 4B

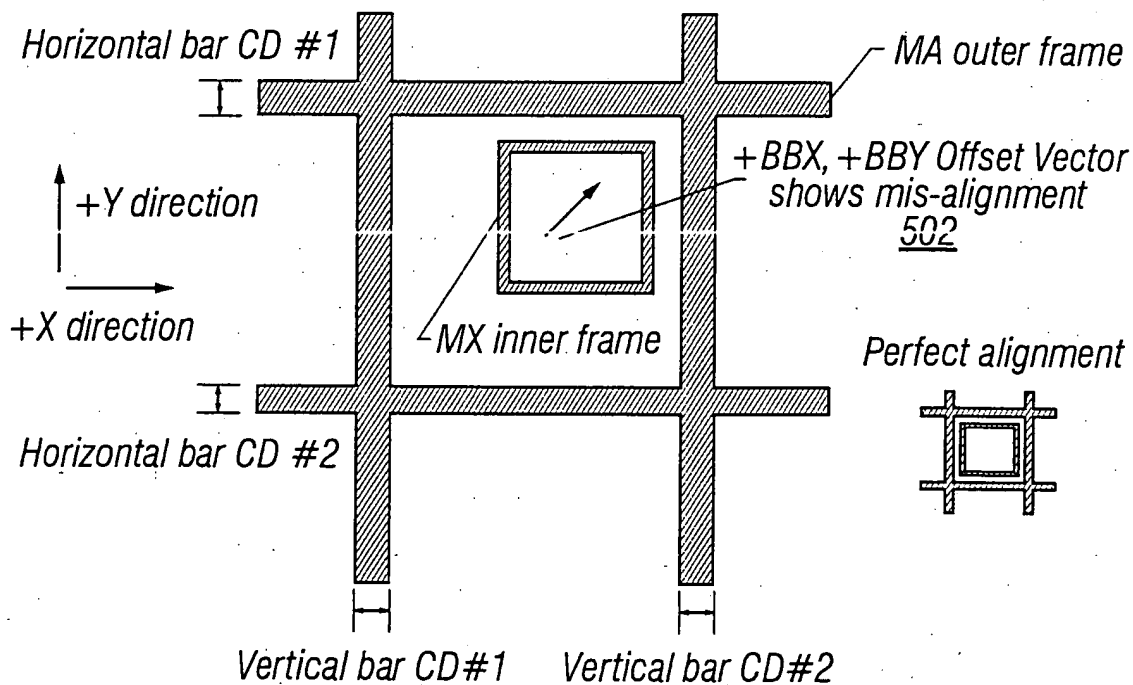


FIG. 5A



$CD(\text{near edge}) < CD(\text{near center})$
 Frame on edge is thinner than center

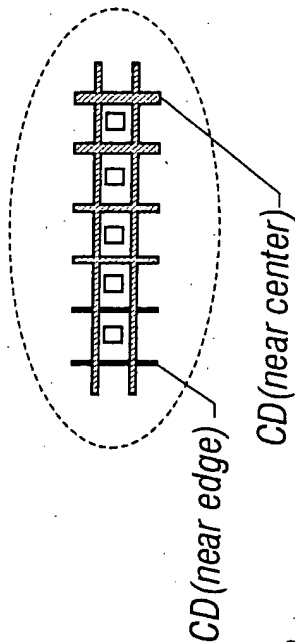


FIG. 5B-2

Typical field point array
 for the "ISI" reticle
 as printed on a wafer.

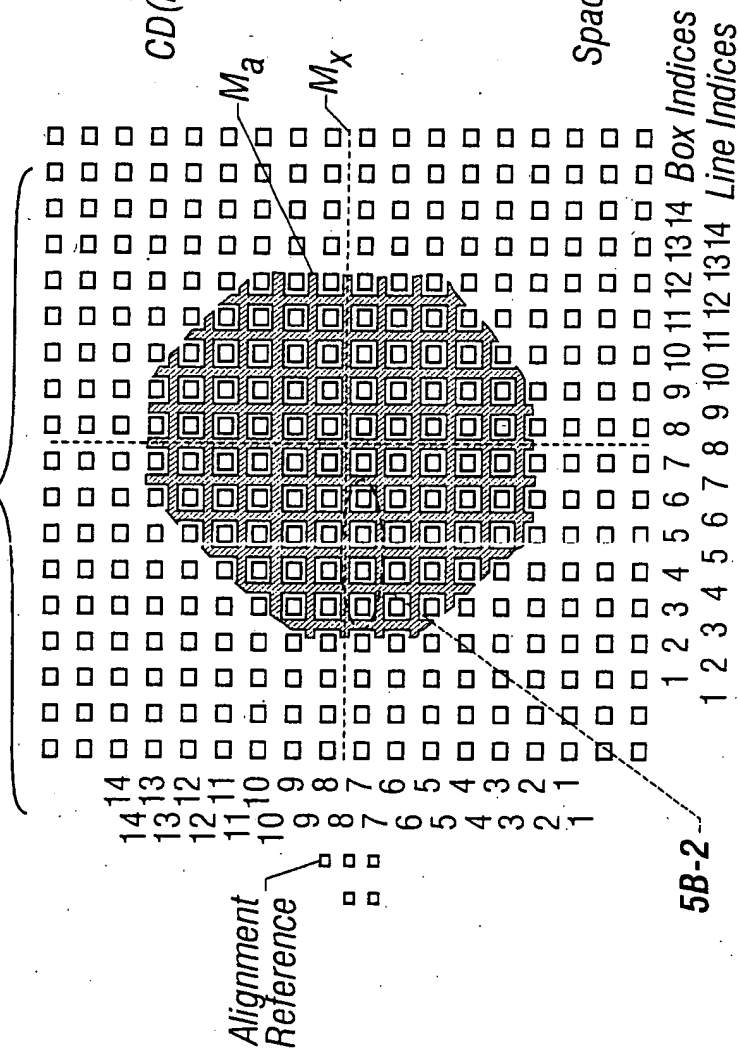


FIG. 5B-1

Overlay measurements using space techniques



FIG. 5B-3

Overlay measurements using CD or edge techniques

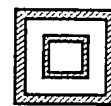


FIG. 5B-4

5B-2

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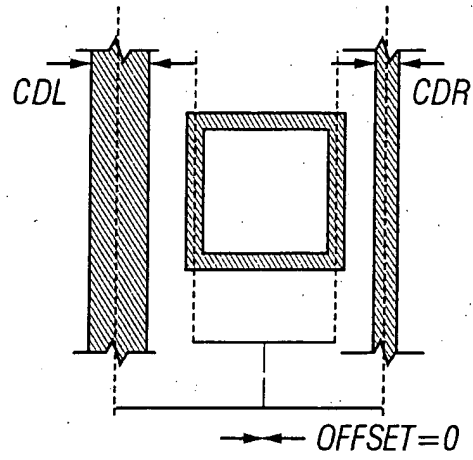


FIG. 5C

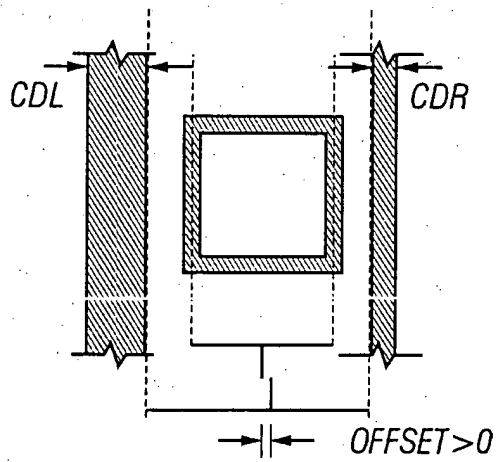


FIG. 5D



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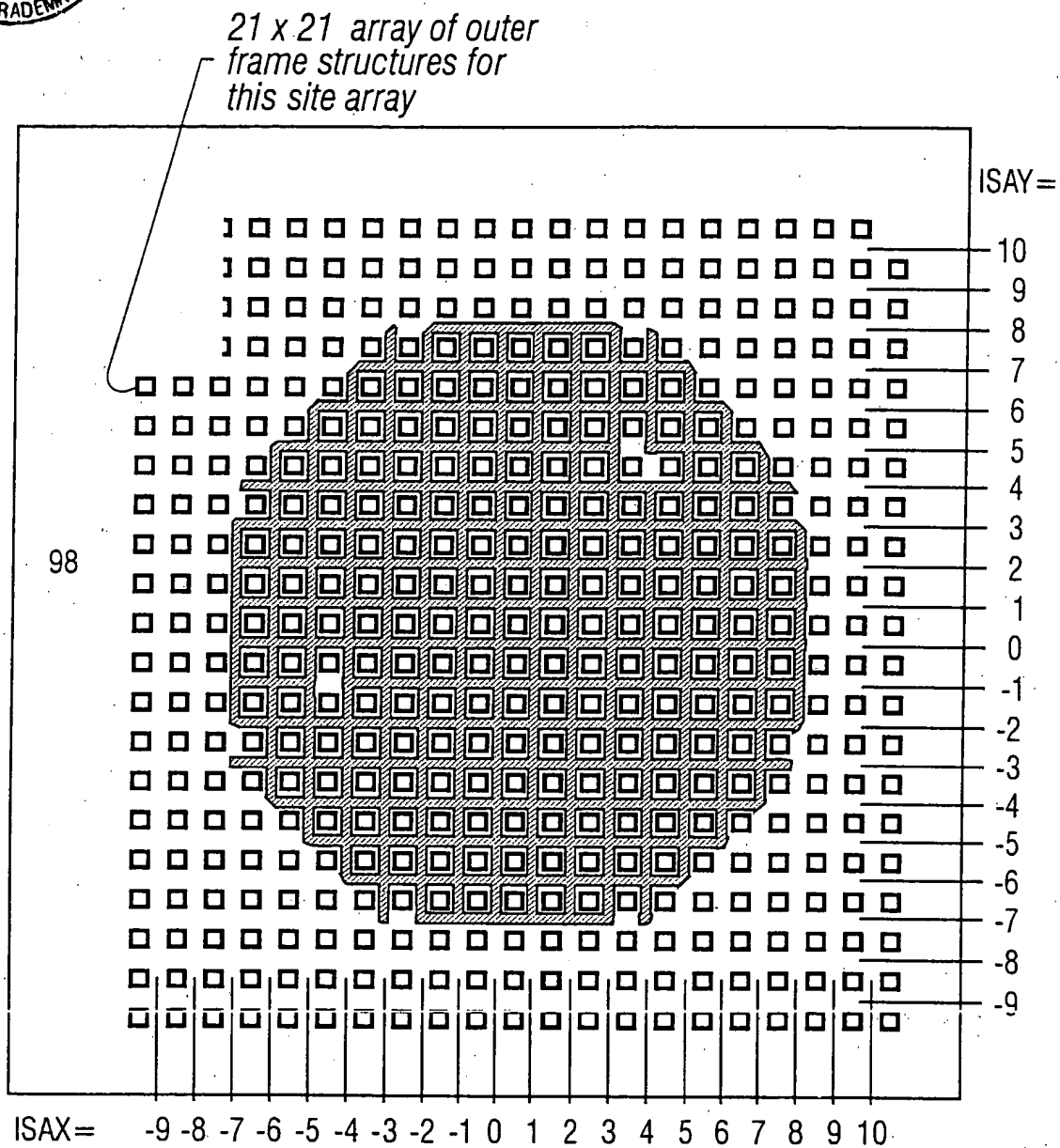


FIG. 6



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FIG. 7

21	1	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
18	BBx															
18	BBy															
17					0.438	0.375	0.313	0.250	0.188	0.125	0.063					
17					-0.125	-0.125	-0.125	-0.125	-0.125	-0.125	-0.125	0.000	-0.063			
16					0.500	0.438	0.375	0.313	0.250	0.188	0.125	0.000	-0.063	-0.125		
16					-0.0625	-0.0625	-0.0625	-0.0625	-0.0625	-0.0625	-0.0625	-0.0625	-0.0625	-0.0625		
15					0.563	0.500	0.438	0.375	0.313	0.250	0.188	0.125	-0.063	-0.125	-0.188	
15					0	0	0	0	0	0	0	0	0	0	0	
14					0.563	0.500	0.438	0.375	0.313	0.250	0.188	0.125	-0.063	-0.125	-0.188	
14					0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	
13					0.625	0.563	0.500	0.438	0.375	0.313	0.250	0.188	-0.063	-0.125	-0.188	-0.250
13					0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
12					0.625	0.563	0.500	0.438	0.375	0.313	0.250	0.188	-0.063	-0.125	-0.188	-0.250
12					0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875	0.1875
11					0.625	0.563	0.500	0.438	0.375	0.313	0.250	0.188	-0.063	-0.125	-0.188	-0.250
11					0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
10					0.625	0.563	0.500	0.438	0.375	0.313	0.250	0.188	-0.063	-0.125	-0.188	-0.250
10					0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125	0.3125
9					0.625	0.563	0.500	0.438	0.375	0.313	0.250	0.188	-0.063	-0.125	-0.188	-0.250
9					0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375
8					0.563	0.500	0.438	0.375	0.313	0.250	0.188	0.125	-0.063	-0.125	-0.188	-0.250
8					0.4375	0.4375	0.4375	0.4375	0.4375	0.4375	0.4375	0.4375	0.4375	0.4375	0.4375	0.4375
7					0.563	0.500	0.438	0.375	0.313	0.250	0.188	0.125	-0.063	-0.125	-0.188	-0.250
7					0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
6					0.500	0.438	0.375	0.313	0.250	0.188	0.125	0.000	-0.063	-0.125	-0.188	-0.250
6					0.5625	0.5625	0.5625	0.5625	0.5625	0.5625	0.5625	0.5625	0.5625	0.5625	0.5625	0.5625
5					0.438	0.375	0.313	0.250	0.188	0.125	0.063	0.000	-0.063	-0.125	-0.188	-0.250
5					0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625
4					0.625	0.563	0.500	0.438	0.375	0.313	0.250	0.188	-0.063	-0.125	-0.188	-0.250
4					0.625	0.563	0.500	0.438	0.375	0.313	0.250	0.188	-0.063	-0.125	-0.188	-0.250
1					0.6875	0.6875	0.6875	0.6875	0.6875	0.6875	0.6875	0.6875	0.6875	0.6875	0.6875	0.6875

FP = 98
IX_0 = 14
IY_0 = 15
DS/DSQ_W = 0.0625



$IX0$ = position within 21×21 array where $(BBx, BBy) = (0,0)$ occurs
 $IY0$
 FP = field point number

IY = Row

12	7 17 111	8 17 112	9 17 113	10 17 114	11 17 115	12 17 116	13 17 117	14 17 118	15 17 119	16 17 120
11	7 16 101	8 16 102	9 16 103	10 16 104	11 16 105	12 16 106	13 16 107	14 16 108	15 16 109	16 16 110
10	7 15 91	8 15 92	9 15 93	10 15 94	11 15 95	12 15 96	13 15 97	14 15 98	15 15 99	16 15 100
9	7 14 81	8 14 82	9 14 83	10 14 84	11 14 85	12 14 86	13 14 87	14 14 88	15 14 89	16 14 90
8	7 13 71	8 13 72	9 13 73	10 13 74	11 13 75	12 13 76	13 13 77	14 13 78	15 13 79	16 13 80
7	7 12 61	8 12 62	9 12 63	10 12 64	11 12 65	12 12 66	13 12 67	14 12 68	15 12 69	16 12 70
6	7 11 51	8 11 52	9 11 53	10 11 54	11 11 55	12 11 56	13 11 57	14 11 58	15 11 59	16 11 60
5	7 10 41	8 10 42	9 10 43	10 10 44	11 10 45	12 10 46	13 10 47	14 10 48	15 10 49	16 10 50
4	7 9 31	8 9 32	9 9 33	10 9 34	11 9 35	12 9 36	13 9 37	14 9 38	15 9 39	16 9 40
3	7 8 21	8 8 22	9 8 23	10 8 24	11 8 25	12 8 26	13 8 27	14 8 28	15 8 29	16 8 30
2	7 7 11	8 7 12	9 7 13	10 7 14	11 7 15	12 7 16	13 7 17	14 7 18	15 7 19	16 7 20
1	7 6 1	8 6 2	9 6 3	10 6 4	11 6 5	12 6 6	13 6 7	14 6 8	15 6 9	16 6 10
	1	2	3	4	5	6	7	8	9	10

$IX = Col$

FIG. 8

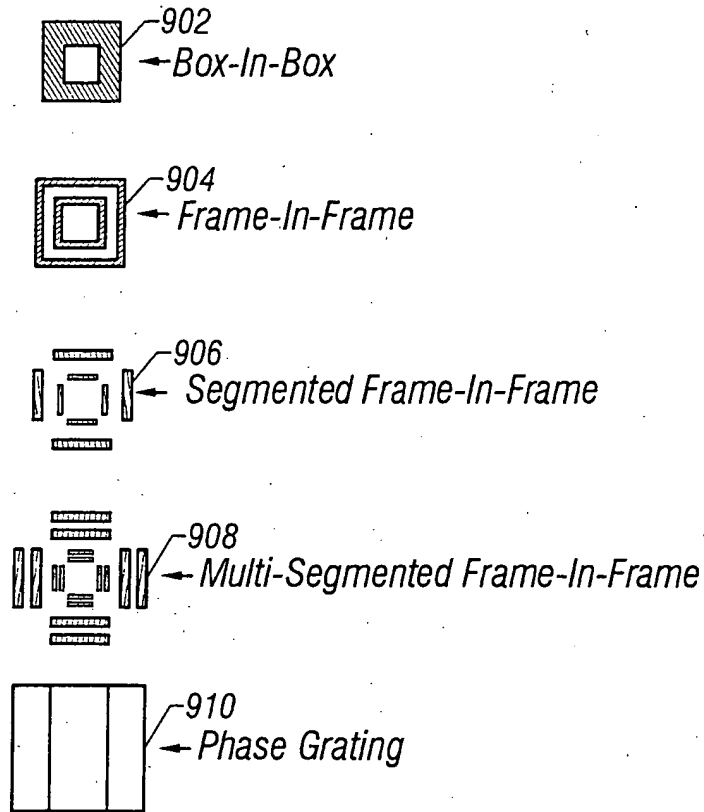


FIG. 9

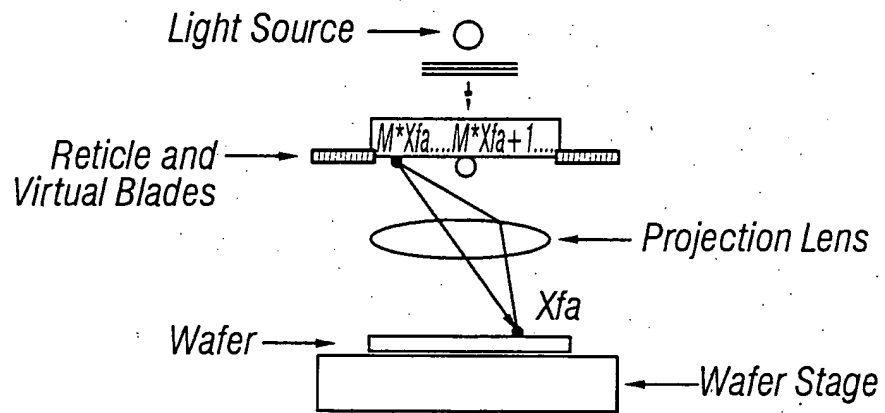


FIG. 10



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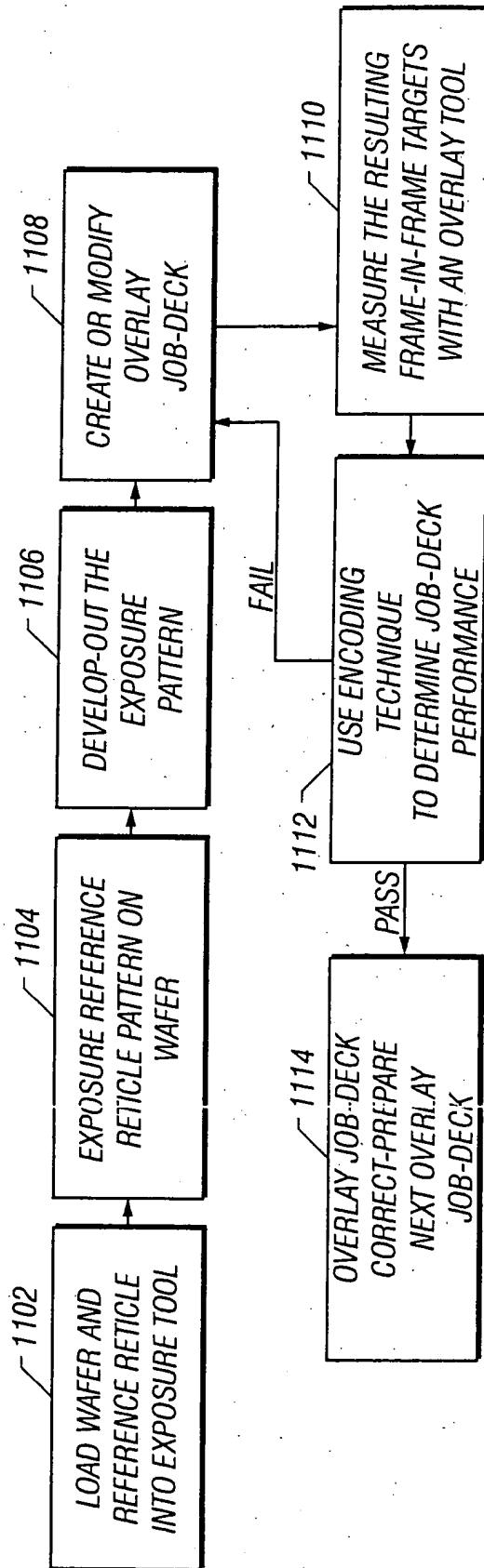


FIG. 11

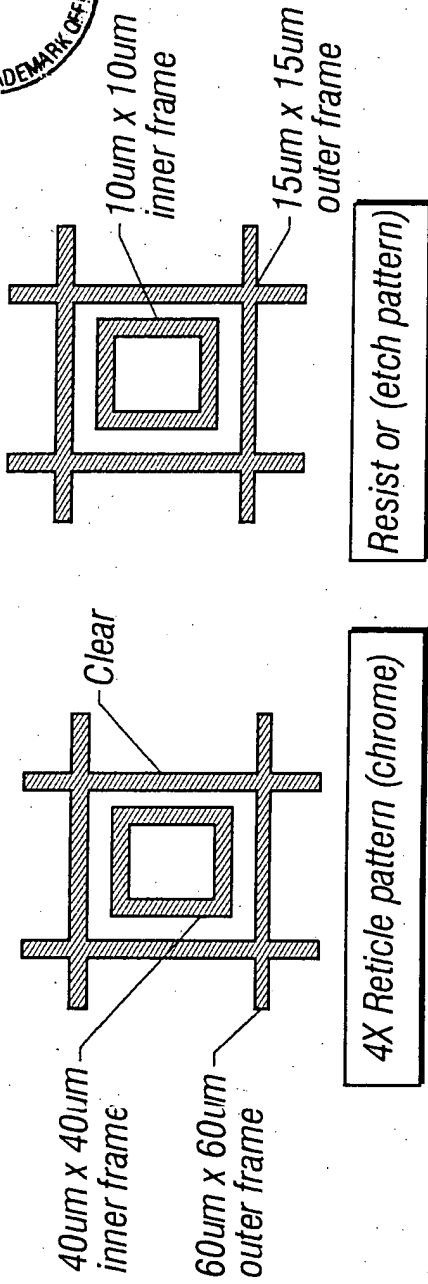
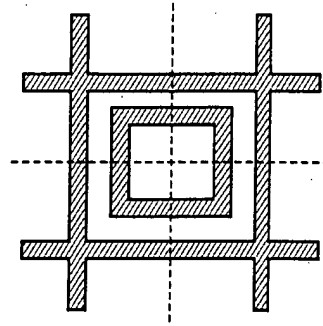


FIG. 12



Centered Frame-in-Frame structure
No shift: ISAX=0, ISAY=0

FIG. 13

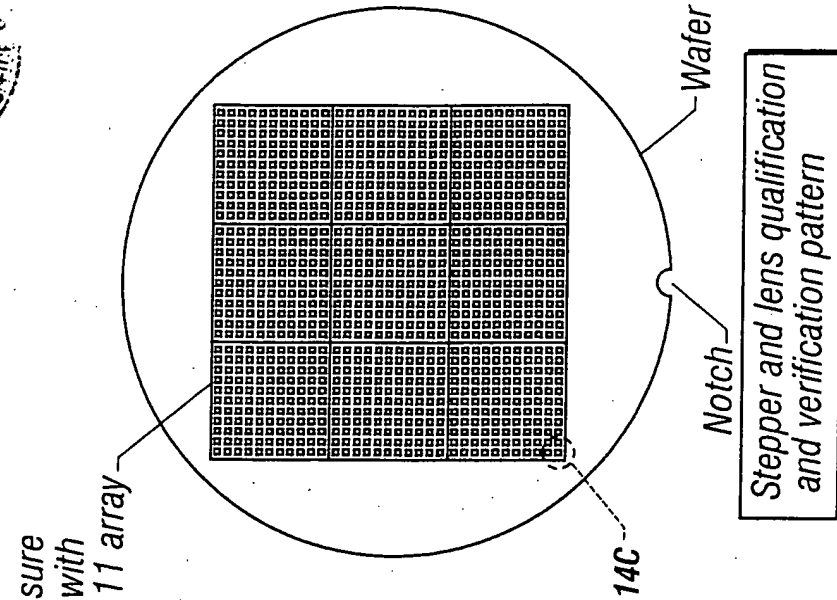
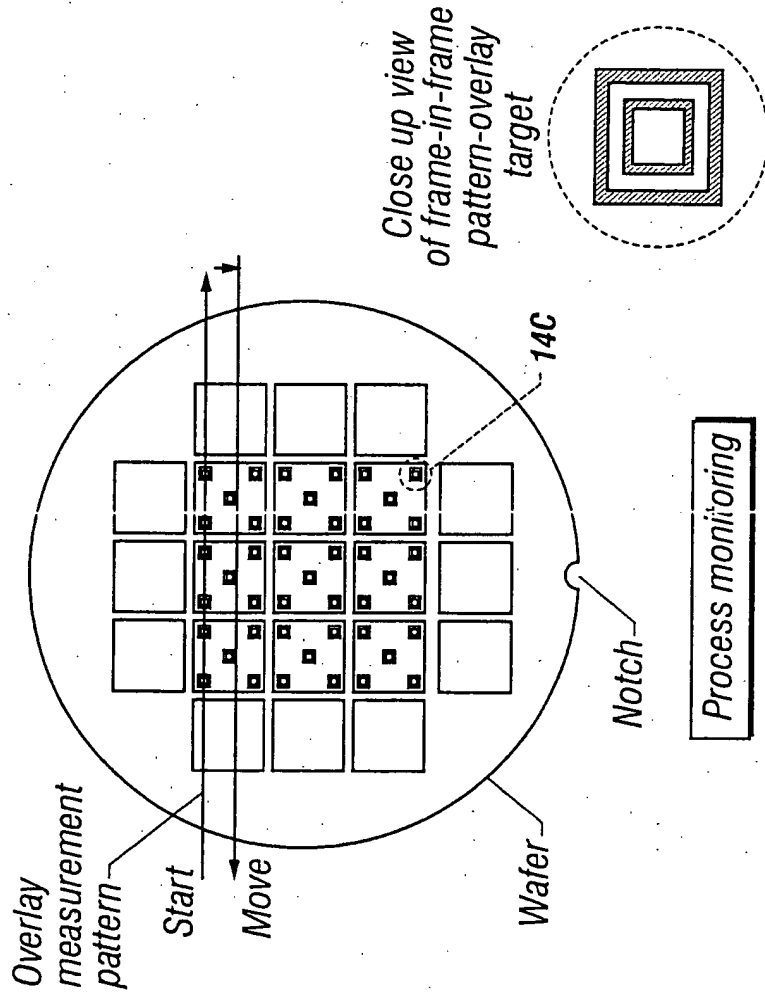
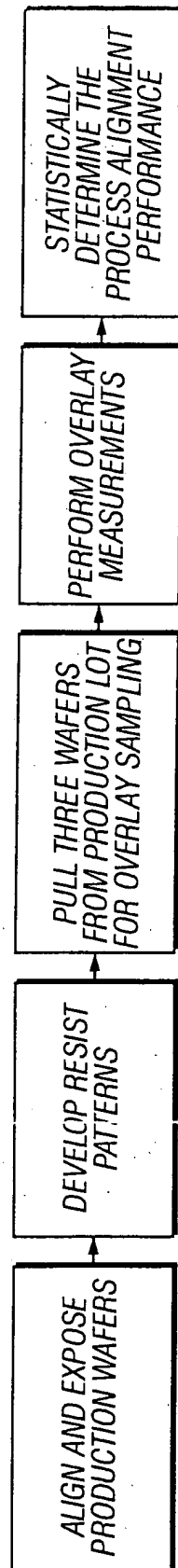
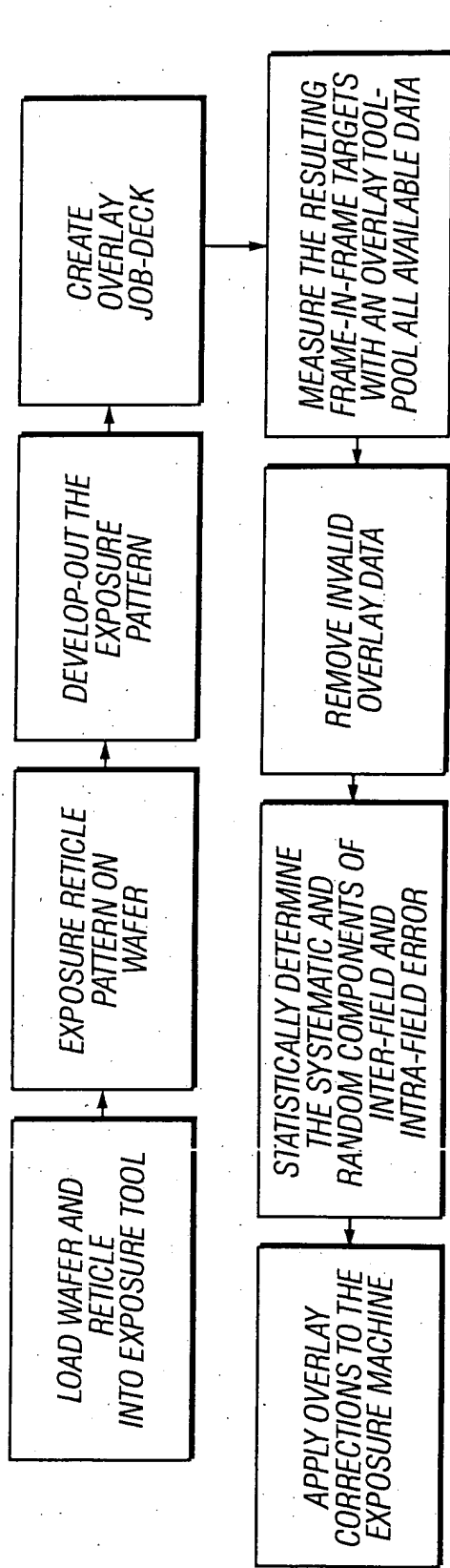


FIG. 14B





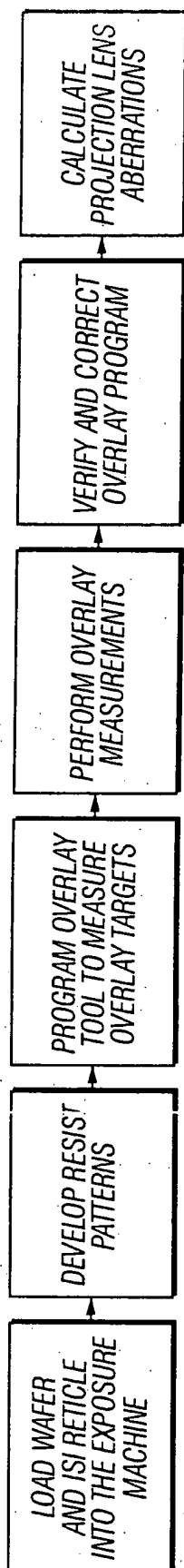


FIG. 15C